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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte STEVEN D. BURCH and JOHN C. FAGLEY

Appeal 2007-4377
Application 10/623,674
Technology Center 1700

Decided: August 21, 2008

Before CHUNG K. PAK, PETER F. KRATZ, and JEFFREY T. SMITH, *Administrative Patent Judges*.

KRATZ, *Administrative Patent Judge*.

DECISION ON APPEAL

1This is a decision on an appeal under 35 U.S.C. § 134 from the Examiner's final rejection of claims 1-12, 15-18, 20-22, and 24-30. We have jurisdiction pursuant to 35 U.S.C. § 6.

Appellants' claimed invention is directed to a fuel cell system including, *inter alia*, a primary reactor for reforming a fuel and a high temperature proton exchange membrane fuel cell (HT-PEMFC) stack in fluid communication therewith. Claims 1, 5, 7, 8, 15, 21, and 27 are illustrative and reproduced below:

1. A fuel processor based fuel cell system comprising:

a primary reactor adapted to generate a gaseous reformate from feed inputs comprising steam;

a high temperature proton exchange membrane fuel cell (HT-PEMFC) stack in fluid communication with the primary reactor, said HT-PEMFC stack is adapted to receive the gaseous reformate for generating electrical power and to generate the steam needed for the primary reactor;

a compressor adapted to provide compressed air to the HT-PEMFC stack;

an anode exhaust condenser and a cathode exhaust condenser adapted to receive heat energy from a respective exhaust from the HT-PEMFC and to heat air used by the compressor; and

a stack excess steam condenser, wherein the air is also used to condense a portion of the steam provided to the excess steam condenser before being fed to the compressor.

5. A fuel processor based fuel cell system according to claim 1 further comprising a WGS reactor heat exchanger provided in fluid communication between a WGS reactor and the HT-PEMFC stack, the WGS reactor heat exchanger is adapted to heat the steam before being used in the primary reactor with heat energy from the gaseous reformate.

7. A fuel processor based fuel cell system according to claim 1 wherein a portion of about two-thirds to about one-half of vaporized water in the steam is recondensed in the stack excess steam condenser and recycled to the HT-PEMFC stack for cooling needs.

8. A fuel processor based fuel cell system according to claim 1 wherein a portion of about one-third to one-half of vaporized water in the steam is used in the primary reactor.

15. A fuel processor based fuel cell system according to claim 1 further comprising an anode exhaust preheat heat exchanger receiving anode exhaust from the HT-PEMFC stack and a bypass circuit used to divert the gaseous reformate into the anode exhaust preheat heat exchanger to provide greater heat input to the anode exhaust before sending the gaseous reformate to the HT-PEMFC stack.

21. A fuel processor based fuel cell system comprising:

a reactant stream comprising steam;

a primary reactor adapted to generate a gaseous reformate using the reactant stream;

a primary reactor heat exchanger in fluid communication with the primary reactor to preheat the reactant stream;

a high temperature proton exchange membrane fuel cell (HT-PEMFC) stack adapted to receive the gaseous reformate for generating electrical power, the HT-PEMFC stack being cooled by water and the steam being provided via water vaporization of the water in the HT-PEMFC stack;

a catalytic combustor; and

a superheat heat exchanger adapted to receive heat energy from the catalytic combustor to superheat the reactant stream, the superheated reactant stream is then combined with compressed air before being used in the primary reactor.

27. A fuel processor based fuel cell system according to claim 21 further comprising a water injector used to put water into the reactant stream prior to entering into the superheat heat exchanger in order to provide the required steam for the primary reactor at startup.

The Examiner relies on the following prior art reference as evidence in rejecting the appealed claims:

Bloomfield	3,982,962	Sep. 28, 1976
Beshty	4,670,359	Jun. 2, 1987
Okada	5,302,470	Apr. 12, 1994
Buswell	5,360,679	Nov. 1, 1994
Grasso	US 2001/0004500 A1	Jun. 21, 2001
Van Dine ('366)	US 6,331,366 B1	Dec. 18, 2001
Clawson	US 2002/0004152 A1	Jan. 10, 2002
Cownden	US 2002/0015870 A1	Feb. 7, 2007
Towler	US 6,375,924 B1	Apr. 23, 2002
Kunitake	US 2002/0046889 A1	Apr. 25, 2002
Hallum	US 2002/0081466 A1	Jun. 27, 2002
Cutright	US 2002/0160239 A1	Oct. 31, 2002
Okamoto	US 2002/0177016 A1	Nov. 28, 2002
Van Dine ('025)	US 2003/0027025	Feb. 6, 2003

Mugerwa, M.N. et al., eds *Fuel Cell System*, Plenum Press New York, Pgs. 202,228,229, (1993)

Baukal, Jr., C. E., *Heat Transfer In Industrial Combustion*, CRC Press. Boca Raton, Sections 2.2., 8.414 (2000)

Anthony R. Eggert et al., *Characteristics of an Indirect-Methanol Fuel Cell System*, American Institute of Aeronautics & Astronautics, 2000-3040, Pgs. 1326-1332

Claims 1-3 and 6-9 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Grasso in view of Bloomfield and Mugerwa. Claim 4 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Grasso in view of Bloomfield, Mugerwa, and Beshty. Claim 5 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Grasso in view of Bloomfield, Mugerwa, and Towler. Claim 10 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Grasso in view of Bloomfield, Mugerwa, Clawson, and Baukal, Jr. Claims 11 and 20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Grasso in view of

Bloomfield, Mugerwa, and Buswell. Claim 12 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Grasso in view of Bloomfield, Mugerwa, and Okada. Claim 15 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Grasso in view of Bloomfield, Mugerwa, and Van Dine '661. Claims 16 and 29 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Grasso in view of Bloomfield, Mugerwa, Hallum, and Cownden. Claim 17 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Grasso in view of Bloomfield, Mugerwa, Cutright, and Okada. Claims 18 and 30 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Grasso in view of Bloomfield, Mugerwa, and Kunitake. Claims 21, 22, and 24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Eggert in view of Okamoto. Claim 25 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Eggert in view of Okamoto, and Towler. Claim 26 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Eggert in view of Okamoto, Grasso and Baukal, Jr. Claim 27 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Eggert in view of Okamoto, and Van Dine '025. Claim 28 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Eggert in view of Okamoto, Bloomfield, and Mugerwa.

We affirm the stated rejections for reasons set forth in the Examiner's Answer and below.[1]

Under 35 U.S.C. § 103, the factual inquiry into obviousness requires a determination of: (1) the scope and content of the prior art; (2) the differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) any secondary considerations. *Graham v.*

[1] Our references to the Examiner's Answer herein are to the Answer bearing a mailing date of May 02, 2007.

John Deere Co., 383 U.S. 1, 17-18 (1966). "[A]nalysis [of whether the subject matter of a claim is obvious] need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ." *KSR Int'l Co. Teleflex, Inc.*, 127 S. Ct. 1727, 1741 (2007). *See DyStar Textilfarben GmBH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1361 (Fed. Cir. 2006) ("The motivation need not be found in the references sought to be combined, but may be found in any number of sources, including common knowledge, the prior art as a whole, or the nature of the problem itself.").

The analysis supporting obviousness should "identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements" in the manner claimed. *KSR*, 127 S. Ct. at 1741. However, "[t]he combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." Id. at 1739. In this regard, one of ordinary skill in the art is presumed to have skills apart from what the prior art references expressly disclose. *See In re Sovish*, 769 F.2d 738, 742 (Fed. Cir. 1985).

Moreover, a rejection premised upon a proper combination of references cannot be overcome by attacking the references individually. *In re Keller*, 642 F.2d 413, 426 (CCPA 1981).

We note that Appellants present an overview in subsection A of the Arguments section of the Brief. Then, Appellants present a number of claim groupings in subsections B through I of this section of the Brief. However, some of the claims that are grouped together by Appellants in subsections B through I do not fall under the same rejection. Accordingly, we have

regrouped the claims, as appropriate, in our discussion to indicate where a separate rejection applies to one or more of the so grouped claims and/or to identify the correct claim grouping when commonly rejected claims have not been separately argued with respect to a particular rejection. In this regard, we have considered the rejected claims separately to the extent arguments for the separate patentability of the rejected claims are presented in the Brief and/or Reply Brief.

Claims 1-3 and 6-9

Claims 1-3 and 6 are argued together as a group and dependent claim 9 is not separately argued. We select claim 1 as the representative claim for this revised claim grouping of claims 1-3, 6, and 9.

Appellants do not dispute that Grasso teaches or suggests a fuel cell system including: (1) a reforming (primary) reactor having provision for steam input and (2) a proton exchange membrane fuel cell (PEMFC) stack in communication therewith for generating electrical current (power) using the gaseous reformate. Nor do Appellants deny that Grasso teaches or suggests oxidant supply equipment, such as a blower (98) for supplying air to the fuel cell stack. Furthermore, Appellants do not contest that Bloomfield discloses a fuel cell power plant wherein an air compressor (38) is furnished to supply air to a power plant fuel cell and condensing heat exchangers (54) and (80) are employed to condense water from cathode and anode exhaust steams of a fuel cell with provision for using air as a coolant (Br. 8 and 12-15). Also, Appellants acknowledge Mugerwa's teaching that "the greater the degree of interaction possible between the fuel cell and fuel processing subsystems the

better the combined performance and system design will be" (Br. 13; Mugerwa, p. 202).

Rather, Appellants basically assert that Grasso alone or, in combination with the other applied references, would not have taught or suggested the provision of the required HT-PEMFC stack to one of ordinary skill in the art together with an air compressor, anode and cathode exhaust condensers adapted to heat air that is to be compressed by the compressor, and a stack excess steam condenser arranged for heating compressor air as allegedly called for by representative claim 1 (Br. 13-15; Reply Br. 1-4). The Examiner contends otherwise (Ans. 4-8).

Consequently, the principal issues generated by this appeal with respect to the Examiner's obviousness rejection of claims 1-3 and 6 is: Have Appellants identified reversible error in the Examiner's obviousness rejection of representative claim 1 by the aforementioned assertions by Appellants, as further detailed in the Briefs? We answer this question in the negative and we affirm then Examiner's obviousness rejection of claims 1-3, 6, and 9.

Concerning the required HT-PEMFC stack, the Examiner has correctly found that Grasso discloses a PEMFC stack. In this regard, Appellants have defined a HT-PEMFC stack as a PEMFC stack that operates at temperatures, such as about 100 to about 150 degrees Celsius, which operating temperatures are higher than the temperature at which a conventional PEMFC stacks typically operates at, such as about 60 to about 90 degrees Celsius (Specification ¶ 0004). Appellants' Specification does not detail how an HT-PEMFC stack is constructed differently from a conventional PEMFC stack other than to note this method of operation

temperature difference. Nor do Appellants marshal evidence that establishes that a PEMFC stack, such as disclosed by Grasso, is incapable of operating at a temperature between about 100 to about 150 degrees Celsius, a temperature range at which Appellants acknowledge a HT-PEMFC stack typically operates at. While we do not share the Examiner's viewpoint that about 100 degrees Celsius encompasses about 90 degrees Celsius, we do share the Examiner's ultimate obviousness conclusion bottomed on the Examiner's determination that the PEMFC stack of Grasso reasonably appears to correspond with and/or render prima facie obvious the HT-PEMFC stack called for by the representative claim 1 fuel cell system. This is because representative claim 1 is drawn to apparatus, not a process requiring a particular process operating temperature. Under the circumstances recounted above wherein a particular structural distinction is not disclosed in Appellants' Specification to distinguish a HT-PEMFC stack from a PEMFC stack as disclosed by Grasso but rather a method of operation or functional distinction is asserted, it is reasonable to shift the burden to Appellants to establish that the PEMFC stack of Grasso would not be capable of functioning as a HT-PEMFC stack; that is, at a temperature such as about 100 degrees Celsius. *See In re Best*, 562 F.2d 1252, 1255 (CCPA 1977). Whether the rejection is based on § 102 or § 103, the burden of proof is the same, and its fairness is evinced by the inability of the PTO to obtain and compare prior art products. *Id. See also In re Spada*, 911 F.2d 705, 708-09 (Fed. Cir. 1990).

In addition, even if Appellants had furnished evidence establishing a structural distinction between the claimed HT-PEMFC stack over a PEMFC stack as disclosed by Grasso, we have no doubt that the level of skill of an

ordinarily skilled artisan is such that to substitute a HT-PEMFC stack for the PEMFC stack of Grasso in order to take advantage of the higher operating temperatures thereof would have been an obvious matter readily within an ordinarily skilled artisan's capability.[2] In this regard, Grasso discloses that fuel cells other than PEM fuel cells can be employed as alternatives (¶ 0051). Moreover, Bloomfield discloses a fuel cell power plant wherein the fuel cell operates at temperatures high enough such that steam can be generated via heat exchange of cooling water with the fuel cell stack. This steam can be used in the steam reforming (primary) reactor component of the fuel cell power generation system (col. 5, ll. 28-44). On this record, we determine that employing an HT-PEMFC stack in a fuel cell power plant system, such as taught to be known by Grasso, was, at the least, an obvious option that would have been within the grasp of an ordinarily skilled artisan.

As for the condensers and air compressor called for in the claim 1 fuel cell power generation system, we further note that Grasso discloses a stack coolant heat exchanger (76) wherein air is employed to cool the coolant. Obviously, such an exchanger is capable of functioning as, or being substituted by, a steam condenser where HT-PEMFC operating conditions are employed in the fuel cell stack such that some steam is present in the

[2] Indeed, Appellants' Specification does not detail how their HT-PEMFC stack is made. Hence, Appellants inferentially acknowledge that the specifics of how to make a usable HT–PEMFC stack would have been a matter within the level of skill of an ordinarily skilled artisan by leaving such lack of detail out of their Specification. Correspondingly, Appellants would appear to be precluded from persuasively contending that the formation and use of HT-PEMFC stacks was not within the level of ordinary skill in the art at the time Appellants' invention was made, on this record. Also, see, for example, our commentary below respecting Clawson in the discussion of the Examiner's rejection of claim 10 as set forth herein.

coolant fluid. See, for example, the condenser heat exchanger (102) of Bloomfield, which would have been an obvious substitute for a non-condensing heat exchanger for the stack gas coolant where steam formation results therein. As for the claimed anode and cathode exhaust condensers, Grasso discloses that the use of such condensing heat exchange devices for recovering water from exhaust streams of a fuel cell is a well known feature, albeit Grasso indicates the effectiveness of such condensing heat exchangers for maintaining water balance may be compromised under some circumstance when the coolant air is at a high ambient temperature (¶¶ 0006-0011). While Grasso further discloses that a mass (water) transfer and heat transfer device (92) can be employed to transfer heat and water to an incoming air stream from exhaust streams of the fuel cell power plant, Grasso clearly conveys the prior art option of employing steam condensers as a known. even if less preferred, alternative or adjunct thereto.

Furthermore, the Examiner reasonably relies on Bloomfield to additionally evince that providing condensing heat exchangers for cathode and anode exhaust streams from a fuel cell power plant and furnishing an air compressor for supplying pressurized air to the fuel cell are known and obvious options that would have been available for one of ordinary skill in the art to employ in the fuel cell power plant of Grasso so as to obtain the expected waste heat recovery, water recovery and pressurized power plant benefits to be expected from employing such known options in Grasso's fuel cell power plant system (Ans. 4-8; Bloomfield, condensers 54, 80, and 102, and compressor 38, Fig. 1 and corresponding description in the Patent text). In this regard, we are satisfied that the evidence before us, including Grasso, Bloomfield and Mugerwa, would have led one of ordinary skill in the art to

select workable and/or optimal heat recovery, air supply, water recovery and steam generation equipment arrangements for the fuel cell power plant of Grasso when employing higher temperature operating conditions in a PEMFC stack and/or when selecting an HT-PEMFC stack as an option. In so doing, we determine that one of ordinary skill in the art would have obviously arrived at a fuel cell power generating system encompassed by the representative claim 1 system, which includes anode, cathode and stack cooling medium condensers, and an air compressor adapted for arrangement like Appellants' claimed system, including condensers adapted for heating air (the condenser cooling fluid) which air can be used as compressor feed air, and which arrangement yields predictable results.

Appellants have not advanced evidence of unexpected results, much less results commensurate in scope with their claimed system.

On this record, we agree with the Examiner that representative claim 1 embraces subject matter that would have been obvious to one of ordinary skill in the art based on the evidence before us.

As for dependent claims 7 and 8, Appellants additionally argues that the Examiner employs impermissible hindsight and an in appropriate obvious to try rationale in asserting that the fractions of steam to be condensed and recycled as required by claim 7 and/or in asserting that the portions of vaporized water to be employed in the primary reactor (reformer) as specified in claim 8 would have been obvious to one of ordinary skill in the art (Br. 7-8).

From our perspective, the additional arguments as furnished by Appellants with respect each of claims 7 and 8 are not persuasive of reversible error in the Examiner's obviousness rejection of either of these

dependent claims. As we noted above, independent claim 1 is drawn to a system, which is an apparatus and not a process. Here, Appellants have not persuasively explained how each of dependent claims 7 and 8 add further structure to the structure required by the system of claim 1 such that either of these dependent claims sets forth subject matter that is separately patentable over the combined teachings of the references applied by the Examiner. In this regard, we are not persuaded by the arguments that one of ordinary skill in the art would have been so limited in skill as to be unable to determine and employ appropriately sized equipment and piping associated with the modified Grasso apparatus, which we discussed above, so as to accommodate workable amounts of heat exchange capacity for condensate formation and coolant loop flow for the fuel cell stack as may be required by claim 7 and so as to accommodate appropriate amounts of steam flow for supply to the reformer as may be required by claim 8.

Accordingly, we shall sustain the Examiner's obviousness rejection of claims 1 and 3-9.

Claim 4

Claim 4 depends from claim 1 and further requires that the fuel cell power generating system of claim 1 further includes a catalytic combustor that is in communication with a heat exchanger for further heating (superheating) steam that is to be used in the primary reactor (reformer).

The Examiner separately rejects claim 4 as being obvious, within the meaning of § 103(a), as being unpatentable over Grasso in view of Bloomfield, Mugerwa, and Beshty. As pointed out by the Examiner, both Grasso and Bloomfield disclose the use of burners (combustors) as part of their fuel cell power generating systems (Ans. 9). Grasso discloses a

catalytic burner (40) as an option for oxidizing anode exhaust combustibles, such as hydrogen, and which burner supplies heat for generating steam, which steam can be used in a reformer (¶ 0032). Bloomfield discloses a burner (20) for supplying heat to a reformer (18). Beshty discloses that a superheated vaporized mixture can be fed to a reformer wherein a burner (47, Fig. 2) is employed in fluid communication with a superheating heat exchanger (26, Fig. 2) to superheat a steam mixture being fed to a reformer (23, Fig. 2). Based on the combined teachings of the applied references, the Examiner determined that it would have been obvious to one of ordinary skill in the art to modify a fuel cell power plant according to Grasso and as modified by Bloomfield, to include a superheating heat exchanger arranged with a catalytic combustor and primary reactor as required by claim 4 and as taught to be an option by Beshty for efficient thermal management of the system (Ans. 9).

Appellants' arguments against the Examiner's separate rejection of dependent claim 4 rest on the arguments made urging the non-obviousness of claim 1, from which claim 4 depends. In light of our agreement with the Examiner's obviousness position as to claim 1 and lacking any other argument that shows reversible error in the Examiner 's separate rejection of claim 4, it follows that we shall sustain the Examiner's obviousness rejection of claim 4 over Grasso in view of Bloomfield, Mugerwa, and Beshty.

Claim 5

Claim 5 depends from claim 1 and further requires that the fuel cell power generating system of claim 1 further includes a water gas shift (WGS) reactor heat exchanger provided in communication with a WGS reactor and the HT-PEMFC stack. The WGS reactor heat exchanger is adapted to heat

steam before the steam is used in the primary reactor employing heat energy from gaseous reformate.

The Examiner separately rejects claim 4 as being obvious, within the meaning of § 103(a), as being unpatentable over Grasso in view of Bloomfield, Mugerwa, and Towler.

Grasso discloses that a WGS reactor (64) is employed between a reformer (58) and the PEMFC stack, which stack we have determined, for reasons set forth above, to be the structural equivalent of or obviously interchangeable with the here-claimed HT-PEMFC stack (Grasso, ¶ ¶ 0032-0034).

The Examiner has found that:

> Towler discloses a shift effluent cooler (Figure 1, 61: applicant's WGS reactor heat exchanger) receiving a shift effluent stream (Figure 1, 60: applicant's gaseous reformate) from a shift reaction zone (applicant's WGS reactor) where it heats and partially vaporizes, by indirect heat exchange, a deionized water stream (Figure 1, 40; Col. 12, ll. 16-27). The shift effluent stream then continues to the fuel cell (Figure 1; streams 60', 71, fuel cell 72). While the Towler reference does not teach that the water stream is that which has been used in cooling the fuel cell, the shift effluent cooler would be capable of receiving and heating such a stream in place of the deionized water stream disclosed. The cooler works to decrease the temperature of the effluent stream to effective oxidation conditions and to heat and partially vaporize the water stream.

Ans. 10.

Towler further discloses that the WGS reactor heat exchanger (60) is arranged such that the fluid stream (water 40) heated therein can be supplied to the reformer (primary) reactor (col. 10, ll. 28-44) of their fuel cell electric power generation system. Given the teachings of Towler in combination with Grasso, Bloomfield, and Mugerwa, the Examiner has determined that:

> it would have been obvious to one of ordinary skill in the art at the time the invention was made to have included a heat exchanger as taught by Towler et al. to heat the water/steam being sent to the reformer between the WGS reactor and the fuel cell stack taught by Grasso et al. and Bloomfield with reformate heat so that less additional equipment and heating utilities would be necessary for efficient thermal management within the fuel cell power plant.

Ans. 11

Appellants, in contrast, maintain that Towler alone or in combination with the other applied references does not teach or suggest using a WGS heat exchanger for heating steam exiting a fuel cell. Appellants contend that one of ordinary skill in the art "would have to experiment blindly" to arrive at the claim 5 subject matter from the applied references' teachings (Br. 15-16). In this regard, Appellants assert that the Examiner employs improper burden shifting and has not met the initial burden of furnishing a prima facie case of obviousness with respect to the claim 5 subject matter, including the WGS reactor heat exchanger arrangement required thereby (Reply Br. 4-6).

Appellants have not persuaded us of reversible error in the Examiner's obviousness rejection of claim 5 by their arguments. In this regard, we note that Bloomfield, one of the other applied references, discloses that steam being furnished to a reformer (primary) reactor from a fuel cell can be heated up along the way from exiting the fuel cell using heat from, among other sources, the water gas shift (WGS) reactor (col. 5, ll. 28-44). Consequently, we are not persuaded that one of ordinary skill in the art would have to experiment blindly to arrive at the claimed subject matter from the combined teachings of the references. To the extent claim 5 requires a WGS heat exchanger that is without the WGS reactor rather than within the WGS reactor as schematically shown by Bloomfield, we have no

doubt that one of ordinary skill in the art would have recognized such an alternative arrangement as an available option. *See KSR*, 127 S. Ct. at 1740-41 (obviousness analysis need not seek out precise teachings directed to the specific subject matter of a challenged claim, but can take account of the inferences and creative steps that a person of ordinary skill in the art would employ); *In re Fritch*, 972 F.2d 1260, 1264-65 (Fed. Cir. 1992) (reference stands for all of the specific teachings thereof as well as the inferences one of ordinary skill in this art would have reasonably been expected to draw therefrom).

On this record, we shall sustain the Examiner's obviousness rejection of claim 5.

Claim 10

Dependent claim 10 requires a catalytic combustor in communication with a combustor air preheat heat exchanger, which exchanger is adapted to receive heat energy from combustor exhaust.

The Examiner separately rejects claim 10 as being obvious, within the meaning of § 103(a), over Grasso in view of Bloomfield, Mugerwa, Clawson, and Baukal, Jr.

We agree with the Examiner's presentation respecting the teachings of Clawson and with the Examiner's obviousness assessment of employing a catalytic burner (combustor) and an associated air heat exchanger in a fuel cell power generation system as called for in claim 10 (Ans. 11-12).

It is worthy to note that Clawson discloses the applicability of their system with PEM fuel cells (PEMFC) that operate at, for example 80 degrees Celsius, and with such proton exchange membrane fuel cells (PEMFC) that operate at higher temperatures, such as above 100 degrees

Celsius, including 120-150 degrees Celsius, temperatures within the range that the here claimed HT-PEMFC stacks of cells are said to require for their operation (Clawson ¶¶ 0036-0038; Specification ¶¶ 0004 and 0016). Thus, Clawson bolsters the Examiner's determination that PEMFC stack is capable of functioning as a HT-PEMFC stack rendering the argued distinction respecting this feature nugatory.

Appellants' arguments against the Examiner's separate rejection of dependent claim 10 rest on the arguments made urging the non-obviousness of claim 1, from which claim 10 depends. In light of our agreement with the Examiner's obviousness position as to claim 1 and lacking any other argument that shows reversible error in the Examiner's separate rejection of claim 10, it follows that we shall sustain the Examiner's obviousness rejection of claim 10 over Grasso in view of Bloomfield, Mugerwa, Clawson, and Baukal, Jr.

Claims 11 and 20

Claims 11 and 20 depend from claim 1 and add separate liquid separator limitations thereto.

The Examiner rejects claims 11 and 20 as being obvious, within the meaning of § 103(a), over Grasso in view of Bloomfield, Mugerwa, and Buswell.

We agree with the Examiner's presentation respecting the teachings of Buswell and with the Examiner's obviousness assessment of employing various liquid separators to recover water as called for separately in claims 11 and 20 in a fuel cell power generation system (Ans. 12-13).

Appellants' arguments against the Examiner's separate rejection of dependent claims 11 and 20 rest on the arguments made urging the non-

obviousness of claim 1, from which these claims depend. In light of our agreement with the Examiner's obviousness position as to claim 1 and lacking any other argument that shows reversible error in the Examiner's separate rejection of claims 11 and 20, it follows that we shall sustain the Examiner's obviousness rejection of claims 11 and 20 over Grasso in view of Bloomfield, Mugerwa, and Buswell.

Claim 12

Claim 12 depends from claim 1 and adds a stack coolant liquid separator to the fuel cell power plant system thereof to separate liquid water from steam exiting the fuel cell stack.

The Examiner rejects claim 12 as being obvious, within the meaning of § 103(a), over Grasso in view of Bloomfield, Mugerwa, and Okada.

We agree with the Examiner's presentation respecting the teachings of Okada and with the Examiner's obviousness assessment of employing various liquid separators to recover water as called for in claim 12 in a fuel cell power generation system (Ans. 14).

Appellants' arguments against the Examiner's separate rejection of dependent claim 12 rests on the arguments made urging the non-obviousness of claim 1, from which these claims depend. In light of our agreement with the Examiner's obviousness position as to claim 1 and lacking any other argument that shows reversible error in the Examiner 's separate rejection of claim 12, it follows that we shall sustain the Examiner's obviousness rejection of claim 12 over Grasso in view of Bloomfield, Mugerwa, and Okada.

Claim 15

Claim 15 depends from claim 1 and adds an exhaust gas preheat heat exchanger and a reformate bypass circuit for diverting reformate to this preheat heat exchanger to furnish heat to the fuel cell stack exhaust gas before forwarding reformate to the fuel cell stack.

The Examiner rejects claim 12 as being obvious, within the meaning of § 103(a), over Grasso in view of Bloomfield, Mugerwa, and Van Dine '366. The Examiner maintains that:

> The Van Dine reference teaches a second heat exchanger (Figures 1, 62: applicant's anode exhaust preheat heat exchanger) in which the anode exhaust (Figures 1, 42) is heated by the reformed fuel (Figures 1, 54: applicant's reformate). The reformed fuel then continues to the fuel cell and the anode exhaust is combusted in a catalytic burner. Preheating the anode exhaust allows for efficient combustion in the burner so that the exhaust stream leaving the burner is non-flammable (Col. 13, II. 7-13 and Col. 7, I1.18-22).
>
> Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have included in the fuel cell power plant as disclosed by Grasso et al. and Bloomfield a heat exchanger for providing greater heat input to the anode exhaust by the reformed fuel in order to more efficiently combust the anode exhaust in the combustor and produce a non-flammable combustor exhaust stream as taught by Van Dine et al. This heat exchanger also provides heat integration within the plant thereby reducing utility costs and efficiency for the plant. The production of a non-flammable combustor exhaust stream is also environmentally advantageous.

Ans. 15

Appellants argue that the bypass circuit of claim 15 inherently requires a diverting device, such as a bypass valve 84, as shown in Appellants' drawing Figure 1, which is not taught by the applied references

(Br. 17). This additional argument as to dependent claim 15 is not persuasive of reversible error in the Examiner's separate rejection of this dependent claim. This is because claim 15 does not require the argued diverting device as part of the bypass circuit. *See In re Self*, 671 F.2d 1344, 1348 (CCPA 1982). Moreover, the provision of a bypass valve for bypassing or not bypassing a particular piece of equipment such as the claimed heat exchanger is a well-known engineering expedient that would have been obvious for one of ordinary skill in the art to employ for such an optional heat exchange to obtain the expected benefit of heating the anode exhaust stream with the reformate, only as desired. In this regard, we note, for example, that Van Dine '366 discloses a bypass valve (77, fig. 1) that serves to either bypass a heat exchanger (68, Fig. 1) or to allow flow to that heat exchanger, as may be desired (col. 8, ll. 40-63).

Appellants' arguments against the Examiner's separate rejection of dependent claim 15 is based on the arguments made urging the non-obviousness of claim 1, from which these claims depends in addition to those arguments specifically advanced with respect to the added features of claim 15. In light of our agreement with the Examiner's obviousness position as to claim 1 and our further agreement with the Examiner's obviousness assessment as to the additional argued features of dependent claim 15, we are of the view that Appellants' arguments do not show reversible error in the Examiner's separate rejection of claim 15. It follows that we shall sustain the Examiner's obviousness rejection of claim 15 over Grasso in view of Bloomfield, Mugerwa, and Van Dine '366 for the reasons stated above and in the Answer.

Claims 16 and 29

Claim 16 depends on claim 1 and further requires the capability for a particular anode stoichiometry for the fuel cell power generating system and claim 29 depends from claim 16 and further limits the anode stoichiometry of claim 16.

The Examiner rejects claims 16 and 29 as being obvious, within the meaning of § 103(a), over Grasso in view of Bloomfield, Mugerwa, Hallum, and Cownden.

The Examiner relies on the teachings of Hallum and Cownden in addition to the references applied against claim 1 in asserting the obviousness of employing a fuel cell power generating system having the capability for providing a stoichiometry as called for in claims 16 and 29 (Ans. 15-17).

Appellants' arguments against the Examiner's separate rejection of dependent claims 16 and 29 rest on the arguments made urging the non-obviousness of claim 1, from which these claims depend (Br. 15). In light of our agreement with the Examiner's obviousness position as to claim 1 and lacking any other argument that shows reversible error in the Examiner's separate rejection of claims 16 and 19, it follows that we shall sustain the Examiner's obviousness rejection of claims 16 and 19 over Grasso in view of Bloomfield, Mugerwa, Hallum, and Cownden.

Claims 17, 18, and 30

Claim 17 depends from claim 1 and further requires the capability for a particular steam to fuel ratio in the primary reactor of the fuel cell power generating system. Claim 18 depends from claim 1 and further requires the capability of furnishing oxygen to carbon in a specified ratio in the primary

reactor of the fuel cell power generating system. Claim 30 depends from claim 18 and further limits the ratio of claim 18.

The Examiner rejects claim 17 as being obvious, within the meaning of § 103(a), over Grasso in view of Bloomfield, Mugerwa, Cutright, and Ogada. The Examiner separately rejects claims 18 and 30 as being obvious, within the meaning of § 103(a), over Grasso in view of Bloomfield, Mugerwa, and Kunitake.

The Examiner relies on the teachings of Cutright and Ogada in addition to the references applied against claim 1 in asserting the obviousness of employing a fuel cell power generating system having the capability for providing a steam to fuel ratio as called for in claim 17. We further note that Cutright discloses that a PEM fuel cell can operate at 120-200 degrees Celsius (¶ 0026).

As for claims 18 and 30, the Examiner relies on the teachings of Kunitake in addition to the references applied against claim 1 in asserting the obviousness of employing a fuel cell power generating system having the capability for providing an oxygen/carbon ratio as called for in claims 18 and 30 (Ans. 17-19).

Appellants' arguments against the Examiner's rejection of claim 17 and the separate rejection of claims 18 and 30 rest on the arguments made urging the non-obviousness of claim 1, from which these claims ultimately depend (Br. 15). In light of our agreement with the Examiner's obviousness position as to claim 1 and lacking any other argument that shows reversible error in the Examiner's separate rejection of claim 17 and the separate rejection of claims 18 and 30, it follows that we shall sustain both of these obviousness rejections as presented by the Examiner.

Claims 21, 22, and 24

Claims 21, 22, and 24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Eggert in view of Okamoto. These commonly rejected claims are argued together as a group (Br. 17). We select claim 21 as the representative claim for this revised claim grouping of claims 21, 22, and 24.

The Examiner has determined that:

> Figure 1 of the Eggert reference shows a reformer (applicant's primary reactor) with a reactant stream of steam and fuel that generates a reformate. The reformate is fed to a PEM fuel cell stack (pg, 1327) that uses the reformate to produce electrical power. The fuel cell stack is water cooled, and the water and thermal management of the fuel cell maintains water self-sufficiency of the system, including water for steam reformation (pg. 1330). An evaporator (applicant's primary reactor heat exchanger) for transferring heat energy from the reformate to the reactant steam is positioned between the reformer and a water-gas-shift reactor. A catalytic burner (applicant's catalytic combustor) burns anode exhaust, fuel, and air to supply heat energy to the reformer and super heaters (applicant's superheat heat exchanger) for superheating the fuel and steam before they are mixed and reacted in the reformer. It is noted that applicant requires a high temperature proton exchange membrane fuel cell (HT-PEMFC); this requirement is met in the Eggert reference's proton exchange membrane (PEM) (pg. 1327). An HT-PEMFC employs a proton exchange membrane. The Eggert reference fails to disclose the addition of compressed air to the superheated stream.
>
> Okamoto teaches a stream of air supplied to the reformer (Figure 1, 6: applicant's primary reactor) from a compressor in the air supply device (Figure 1, 11). The compressed air promotes water vapor reformate reactions and partial oxidation reactions (pg. 2, [0027]). Although the diagram does not show the superheated stream and compressed air stream being mixed

> before entering the reformer, they must be mixed prior to use within the reformer.
>
> Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to mix the superheated reactant stream containing fuel and steam from the super heaters as taught by Eggert et al. with compressed air as taught by Okamoto in order to promote water vapor reformate reactions and partial oxidation reactions.

Ans. 19-20.

Appellants do not argue that Eggert does not teach or suggest a fuel cell electric power generation system including a PEMFC stack that is water cooled and a primary reforming reactor connected therewith, which reformer is adapted to generate a reformate using a reactant stream containing steam. Nor do Appellants dispute that Eggert teaches or suggest a catalytic combustor (burner) and a primary reactor heat exchanger. Also, Appellants do not contest the Examiner's determination that Eggert discloses or suggests a superheat heat exchanger for the reformer input fuel and steam.

Rather, Appellants urge, in a manner similar to their argument against the Examiner's obviousness rejection of claim 1 over other references, that the here-applied references do not teach or suggest the claimed HT-PEMFC stack because of the lower disclosed operating temperature (80 degrees Celsius) of the PEM fuel cell of Eggert. This line of argument is not persuasive for substantially the same reasons as we discussed above in our review of the Examiner's rejection of claim 1. In this regard, representative claim 21 is drawn to an apparatus, not a method requiring the operation of a fuel cell stack at a particular temperature. Hence, the issue raised by this line of contention is whether or not Appellants have established that the PEM stack of Eggert is incapable of operation at temperatures on the order

of about 100 - 150 degrees Celsius and, if so, whether Appellants have further established that employing a HT-PEMFC stack in Eggert would have been an unobvious option to one of ordinary skill in the art. We answer both parts of this question in the negative for the reasons we discussed above with respect to a similar line of argument made against the Examiner's rejection of claim 1.

Furthermore, Appellants contend that the cited references do not teach or suggest the alleged claimed system provision for mixing superheated steam with compressed air prior to entering the reforming reactor. In this regard, Appellants' maintain that Okamoto does not disclose a superheat heat exchanger and mixing compressed air with superheated steam. Also, it is asserted that neither applied reference furnishes a reasonable expectation of success for such an operation, particularly prior to entering a reformer (Br. 18-19).

We are not persuaded of reversible error in the Examiner's obviousness rejection of representative claim 21 by these contentions of Appellants for the reasons well-presented by the Examiner and as further set forth herein. At the outset we note that representative claim 21 is drawn to an apparatus system. Thus, the recitation of a potential use for the apparatus therein; that is, combining superheated steam with compressed air before the mixture is used in a reformer, does not set forth a patentable distinguishing structural feature for the claimed apparatus system. Moreover, even if we interpreted the recited "use" language of claim 21 as requiring a structural connection between a conduit system capable of supplying compressed air for combining with a superheated reactant stream containing steam-containing effluent transport duct that is connected to a heat exchanger, and

which conduit and duct connection is arranged and connected for forwarding the combined steam stream and air to a primary reactor (reformer), we are not persuaded that such equipment and piping connections would not have been within the skill of the art form the combined teachings of the prior art applied by the Examiner. In this regard, one of ordinary skill in the art would readily recognize that the reformer feed streams for a conventional reformer, whether steam and fuel as shown by Eggert or with added air as disclosed by Okamoto, are eventually brought together as a mixture in the reformer whether that mixing occurs prior to entry into the reactor as shown by Eggert or at the reactor inlet (Eggert, Fig. 1; Okamoto ¶ 0002).

Certainly, one of ordinary skill in the art would have recognized that whether apparatus provision is made for the steam and air to be mixed prior to entry into the reforming reactor or after entry are options well within the skill level of an ordinarily skilled artisan and would be expected to yield a reasonable expectation of success and predictable results in reformate formation. On this record, we agree with the Examiner that the apparatus required by representative claim 21 would have been obvious to one of ordinary skill in the art given the teachings of the applied references and the exercising of routine skill level that such an artisan would be expected to possess.

Accordingly, we affirm the Examiner's obviousness rejection of claims 21, 22, and 24 over Eggert in view of Okamoto.

Claim 28

Claim 28 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Eggert in view of Okamoto, Bloomfield, and Mugerwa (Ans. 23-25).

Appellants do not separately address the Examiner's rejection of claim 28 over these references but rather argue against the Examiner's separate rejection of claim 28 on the same basis as the Examiner's rejection of claim 21 was argued against. Because we did not find the arguments against claim 21 persuasive and Appellants have not addressed or contested the additional application of Bloomfield, and Mugerwa to claim 28 in further combination with Eggert and Okamoto, we shall also affirm the Examiner's obviousness rejection of claim 28.

Claim 25

Claim 25 depends on claim 21 and further requires a WGS reactor, a WGS heat exchanger, and a CO-polishing stage.

The Examiner rejects claim 25 as being obvious, within the meaning of § 103(a), over Eggert in view of Okamoto and Towler.

The Examiner relies on the teachings of Towler in addition to the references applied against claim 21 in asserting the obviousness of employing a fuel cell power generating system having the added features of claim 25 (Ans. 20-21).

Appellants' arguments against the Examiner's separate rejection of dependent claim 25 rests on the arguments made urging the non-obviousness of claim 21, from which this claim depends (Br. 19). In light of our agreement with the Examiner's obviousness position as to claim 21 and lacking any other argument that shows reversible error in the Examiner's

separate rejection of claim 25, it follows that we shall sustain the Examiner's obviousness rejection of claim 25 over Eggert in view of Okamoto and Towler.

Claim 26

Claim 26 depends on claim 21 and further requires an anode preheat heat exchanger heated by combustion exhaust.

Claim 26 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Eggert in view of Okamoto, Grasso, and Baukal, Jr. (Ans. 21-22).

The Examiner relies on the teachings of Grasso, and Baukal, Jr. in addition to the references applied against claim 21 in asserting the obviousness of employing a fuel cell power generating system having the added features of claim 26 (Ans. 21-22).

Appellants' arguments against the Examiner's separate rejection of dependent claim 26 rests on the arguments made urging the non-obviousness of claim 21, from which this claim depends (Br. 19). In light of our agreement with the Examiner's obviousness position as to claim 21 and lacking any other argument that shows reversible error in the Examiner's separate rejection of claim 26, it follows that we shall sustain the Examiner's obviousness rejection of claim 26 over Eggert in view of Okamoto, Grasso, and Baukal, Jr.

Claim 27

Claim 27 depends from claim 21 and further requires a water injector for injecting water into the reactant steam prior to entering a superheat heat exchanger.

The Examiner rejects claim 27 as being obvious, within the meaning of § 103(a), over Eggert in view of Okamoto and Van Dine '025.

The Examiner has determined that:

> The Van Dine reference teaches the injection of liquid phase water into a heated hydrocarbon stream. The heat of the hydrocarbon stream, which has been passed through a heat exchanger, vaporizes the water to provide a hydrocarbon/steam mixture. These heating and injection steps can be repeated to reach the desired S:C (pg. 2,[0026], [0029]). Any injected water that is not vaporized by the heat in the hydrocarbon stream would be vaporized in the subsequent heat exchanger. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have included a water injector as taught by Van Dine et al. to put water in the reactant stream before entering the super heater in order to provide the desired S:C at the reformer.

Ans. 23.

In addition to arguments made against the Examiner's rejection of claim 21, Appellants maintain that Van Dine '025 does not teach a superheat heat exchanger and hence does not suggest the claimed water injection into a reaction stream prior to super heating. This argument is not persuasive of reversible error in the Examiner's rejection because the Examiner does not rely on Van Dine '025 for a superheat heat exchanger. Rather, the Examiner relies on Eggert for this disclosure. Based on the combined teachings of the references, we are satisfied that the Examiner has made out a prima facie case of obviousness against claim 27 that is not persuasively rebutted by arguing against the Examiner's rejection as if Van Dine '025 were applied alone. As the other arguments made against this claim on the basis of its dependency on claim 21 are not persuasive for the reasons set forth above, we shall also affirm the Examiner's obviousness rejection of claim 27 as

being obvious over the combined teachings of Eggert in view of Okamoto and Van Dine '025.

CONCLUSION

The decision of the examiner to reject the appealed claims is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED

Pl Initial:
sld

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